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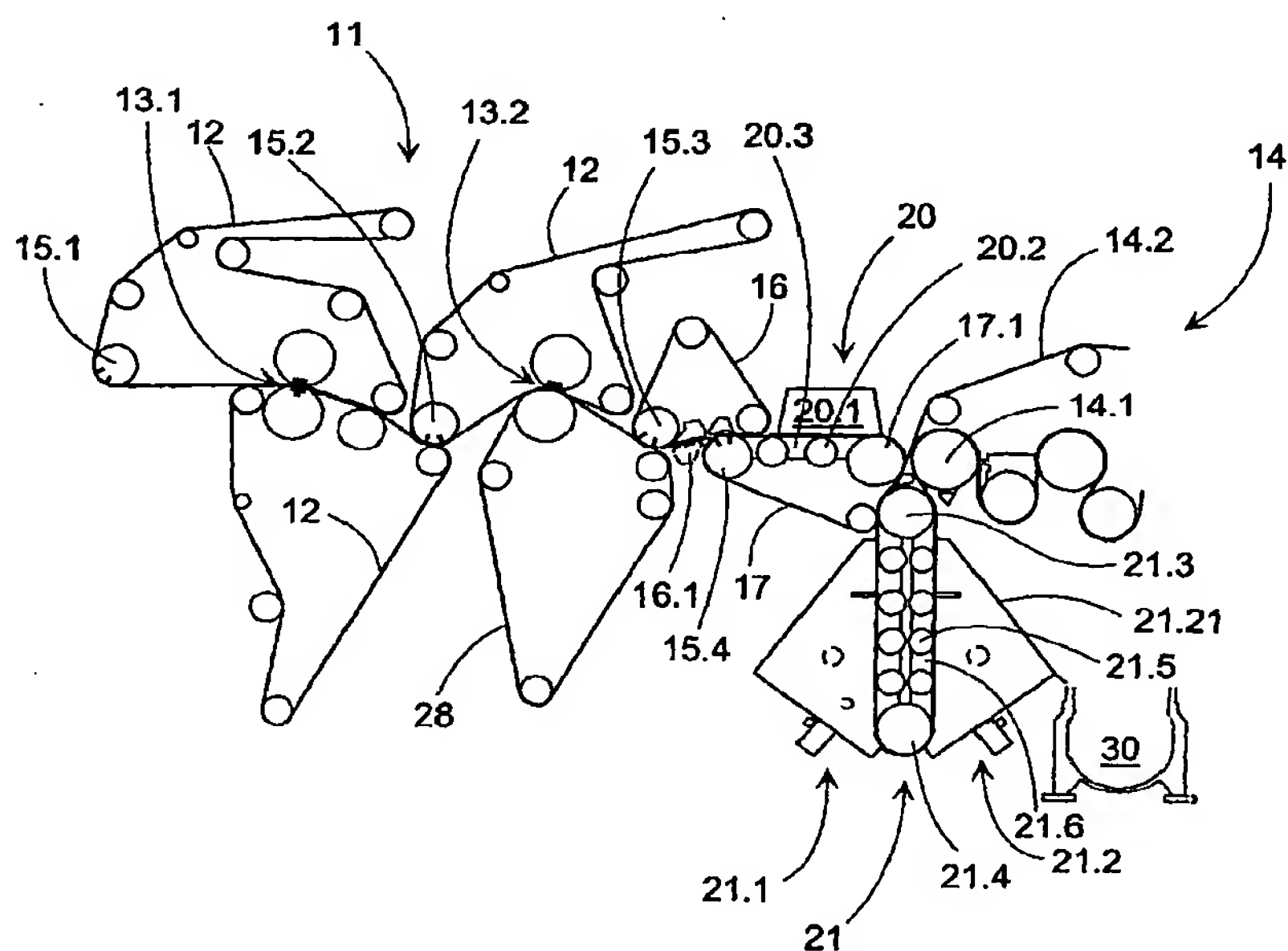
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(54) Title: ARRANGEMENT IN A PAPER MACHINE



(57) Abstract: The invention relates to an arrangement in a paper machine or similar, including a press section (11) equipped with one or more press nips (13.1, 13.2) and a dryer section comprising a web-supporting web transfer. Between the press and the first dryer cylinder there are a compactly arranged preimpingement dryer (20) and a vertical impingement dryer (21).

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## ARRANGEMENT IN A PAPER MACHINE

The invention relates to an arrangement in a paper machine or similar, which includes a press section equipped with one or more press nips and a dryer section comprising a web-supporting  
5 closed web transfer, a vertical impingement dryer and one or more subsequent cylinder dryer groups. The invention relates particularly to impingement unit applications blowing directly to the web.

With increasing paper machine speeds the runnability of the machine becomes very critical  
10 unless measures are taken at the same time for improving runnability. Runnability can be improved until to a certain limit by maintaining a sufficient web tension by means of a speed difference between successive stages. Even this method will become exhausted at the stage when the paper quality starts to deteriorate.

15 Rising paper machine speeds have led to a tendency to preferably use a closed transfer from the press section to the dryer section, and, particularly in a multicylinder dryer, the single fabric run arrangement, as far as possible, even to the end of the cylinder dryer. These are used to get rid of fluttering and similar phenomena, which occur in the free web transfer. From the center roll of the press section the paper web can however be picked up to the dryer section using an open  
20 transfer.

A paper machine dryer section using merely a multicylinder dryer becomes fairly long at high (30-40 m/s) speeds. According to Finnish patent 102623 (WO 97/130131) and Finnish patent application 20002429, impingement dryers are used to replace dryer cylinders, particularly at  
25 the beginning of the dryer section, in which full steam pressure cannot be used in dryer cylinders or steam supply of the first cylinder is sometimes even completely closed. A wet paper web namely attaches to a hot cylinder surface due to which it is necessary to use a lower cylinder surface temperature, whereat drying capacity is lost.

30 In an impingement drying unit, in which impingement takes place directly against the paper web and not through the fabric, it is possible to use fairly high blowing temperatures (250°C-700°C) and thus achieve a very efficient heating effect. The paper web is set to travel

on top of a support fabric, which is supported in the blowing area by a set of rolls either in a straight run or with a large curvature radius. Suction/blow boxes are placed between the rolls for keeping the paper web against the support fabric.

5 According to patent application 20002429 (WO 02/36880), it is possible to spare the machine-directional length by using one or more vertical impingement units. The support fabric has in the vertical direction a notably long loop compared to its machine-directional dimension, at least in the dryer cylinder line. The support fabric remains under the paper web as regards blowing and consequently is not subjected to heat. On both sides of the loop (generally) there  
10 are impingement units, both of which thus have a drying length of even several meters. Keeping the paper web attached to the support fabric is ensured by using internal suction devices, which direct the suction effect to the paper web from inside via the support fabric. The side profile of the impingement surface is straight, slightly curved, possibly variably curved, in a shape of a broken line or a combination of these.

15

The impingement unit comprises a web arrangement that provides support for the paper web and a blowing chamber, which has a perforation on its web side flank for distributing air or other hot gas onto the blowing surface.

20 Space saving is realized also in such a case when the orientation of the unit deviates even remarkably from the vertical, as it will in any case be located in a space below (or above) the paper machine. On the other hand, a vertical construction has the advantage that the earth's gravity cannot disturb the attachment of the fabric to the support surface.

25 In a closed transfer, a great number of fabric loops composed of support fabrics are needed. As the number and total length of these increase, web break risks generally increase. Therefore, the optimization of their number and lengths is aimed at.

Although the above-mentioned known impingement solutions have provided improvements  
30 compared to the prior art technique related to runnability at high speeds and the machine size in the longitudinal direction, the situation has not been completely satisfactory. A simpler, yet a reliable concept is still required.

The bulk of paper [cm<sup>3</sup>/g] is a significant quality factor for many paper grades. However, good bulk is in contradiction with the maximum press section dewatering, because achieving a high dry content after the press requires high nip pressures.

5 According to patent 102623, an impingement unit is located after the press section before the first dryer cylinder. Units blowing through a fabric according to the patent suffer from the blast air temperature limit, since the present drying fabrics cannot be stressed with blast air (or steam) hotter than 200°C. The construction becomes, however, relatively long, and the machine longitudinal saving is not notably achieved with simple solutions. With vertical impingement  
10 units according to patent application 20002429, remarkable savings are achieved much faster in the machine length. With the proposed solutions using vertical impingement units, the runnability is not better than today after the press section.

The object of the invention is to provide an improved arrangement in a paper machine, in which  
15 a vertical impingement unit is used. With the invention, elimination or at least minimization of the above-mentioned drawbacks is aimed at.

The arrangement in a paper machine according to the invention is characterized in what is stated in the appended claims. Impingement dryers are best used to replace exactly the first  
20 cylinder dryers, as their capacity remains rather poor due to a reduced steam pressure. Instead, there are no similar restrictions for straight impingement, and extraordinarily high temperatures can be used in it when blowing directly to the web. An efficient vertical impingement dryer requires however, for ensuring runnability, a preimpingement dryer for drying the opposite side of the paper web at least to a certain extent and by running the moisture gradient growing  
25 towards the bottom surface. At the same time, the preceding efficient web heating enables the full drying capacity of a vertical unit. Preferably a vertical impingement dryer is unilaterally drying and directed to the same side as the first cylinder dryer such that full or almost full steam pressures can be applied starting from the first cylinder, that is, high drying temperatures on the cylinder surface without the risk of sticking.



Here "horizontal" and "vertical" should be understood widely as comprising a deviation of even 45°. In addition, the impingement surface can be curved or a polygon imitating a curved shape or a combination of these.

5 In another embodiment the top surface of the impingement chamber of the vertical impingement unit forms the pulper chute.

In a third embodiment the vertical impingement unit has several support rolls on top of each other, supporting the support fabric from the inside of the fabric loop. Between these rolls,  
10 there are arranged suction boxes in the web direction and in the vicinity of the fabric surface in a method known as such.

In a fourth embodiment, a preimpingement dryer is placed over the section of the press transfer belt and the paper web is transferred therefrom directly to the fabric loop of the vertical  
15 impingement dryer. This is used to replace even two separate transfer fabric loops. This type of combination is particularly compact.

Preimpingement follows immediately after the press already on the press fabric or on the transfer or dryer fabric after the press. The rest of the machine design determines how near to  
20 the press, i.e. how compactly preimpingement can be carried out.

The relative distances between the preimpingement dryer (generally horizontal) and the vertical impingement dryer as well as the first dryer cylinder following those are restricted by the fact that it is not desired that the web cools down excessively in the unheated section. In order to  
25 gain benefit from preimpingement, the web must not cool down between the air blows, but the cooling effect of normal evaporation is still advantageous for the entity with dimensions given later. On the other hand, the web surface temperature should deviate less than 15°C, most preferably less than 8°C, from the dryer cylinder surface temperature (normally approximately 80°C in a paper machine), to avoid harmful sticking of fibers etc. Normally it is allowed that  
30 this interval be 4 meters at the maximum, preferably less than 2 meters. In a compact construction, preimpingement starts at a distance less than 2 meters, most preferably less than 1 meter from the press.

Higher steam pressures are used in board machines, thus the cylinder surface temperature can be as high as 130°C, whereat the deviations can also be greater. In addition, the cylinder may have a temperature profile, in which the edges are warmer than the rest of the cylinder, which can also be taken into account by profiling impingement and/or the steambox.

5

The invention can be fully utilized when a short preimpingement dryer and a vertical impingement dryer are compactly installed between the press and the first cylinder group. Here a vertical impingement dryer equipped with two opposite units can be adapted to a short machine length, and the first dryer cylinder immediately following it can be adapted to essentially full steam pressures. More than one vertical impingement dryers cannot be compactly installed one after another in the machine direction, because the opposite hoods must be installed relatively far from each other. Instead, in addition to the underneath unit, it is possible to have opposite impingement units above the machine, as the arrangement does not increase the machine length.

15

The invention is described below in more detail by making reference to the enclosed drawings, which illustrate some of the embodiments of the invention.

Figure 1 illustrates an arrangement of a paper machine using impingement after the press.

Figure 2 illustrates another arrangement according to the invention.

Figure 3a illustrates a third arrangement according to the invention.

Figure 3b illustrates another embodiment using a steambox.

Figure 4 is a diagram showing the interdependencies between bulk after press and dry matter for some paper grades.

Figure 5 is a diagram showing an embodiment of the second group of the invention.

Figure 6 is a diagram showing the second embodiment of the second group of the invention.

Figure 7 is a diagram showing the third embodiment of the second group of the invention.

Figure 8 is a diagram showing the fourth embodiment of the second group of the invention.

30

Figure 9 is a diagram showing the fifth embodiment of the second group of the invention.

Figure 10 is a diagram showing the sixth embodiment of the second group of the invention.

5

Figures 1-4 depict a paper machine, in which shown are the press section 11 and some of the first sections of the dryer section, namely the preimpingement dryer 20, vertical impingement dryer 21 and a beginning of the cylinder group 14. The first dryer cylinder is indicated with reference number 14.1.

10

The various parts of the arrangement, namely the press section, impingement dryers and cylinder dryers are known for their basic design from e.g. the above-mentioned patent publications.

15 The twin-nip press 11 has nips 13.1 and 13.2. The paper web is picked up in a known manner to the press section 11 with the pick-up roll 15.1 and it is transferred through the nips by means of the press felts 12 and the transfer belt 28. As regards this invention, the design of the press section can vary to a great extent. Particularly essential is however that after the press section 11 (or integrated to its end part) there is a horizontal or preimpingement dryer 20, which in  
20 Figures 1 and 3 uses the dryer fabric 17, against which the blowing unit 20.1 is placed. According to the prior art technique, in the center roll solution there is an open interval in the transfer from the press to drying, and with this embodiment, too, it is possible, irrespective of the press, to arrange an open/openable interval if required when shifting from impingement drying to cylinder drying.

25

Referring to Figure 1, the paper web is picked up from the transfer belt 28 with the transfer suction roll 15.3 and led to the transfer fabric 16, which transports it to the dryer fabric 17 of the horizontal impingement dryer 20 by means of the transfer suction roll 15.4.

30 The paper web travels on top of the dryer fabric 17 from below the blowing unit 20.1, whereat it is subjected to a strong heating effect. In a short blowing zone drying occurs relatively little, but the web warms up and its top surface layer dries slightly. This is however significant as



regards the runnability. At the same time, the moisture gradient in the thickness direction of the web becomes strongly growing towards the bottom surface. Inside the dryer fabric loop 17 there are vacuum boxes 20.3 and support rolls 20.2 for keeping the web attached to the said fabric 17.

5

After the horizontal impingement dryer 20, the paper web is transferred from the dryer fabric 17 after the vacuum roll 17.1 onto the dryer fabric 14.2 of the first dryer cylinder group 14. This same dryer fabric 14.2 is also used by the vertical impingement dryer 21. In a method known as such, the paper web is transferred to the dryer fabric 14.2 by means of the topmost roll 21.3, 10 functioning as a vacuum roll (suction roll or VAC roll), of the vertical impingement dryer 21. The roll 21.3 has a fabric wrap within an area of 3°-10°. The dryer fabric 14.2 is supported in the straight section forming the blowing surface by several small support rolls 21.5, between which there are blow boxes 21.6 providing aspiration for creating a vacuum on the bottom surface of the transfer fabric, i.e. on the opposite surface of the paper web, whereat the paper 15 web becomes aspirated against the transfer fabric 14.2.

The vertical impingement dryer 21 has two opposite impingement units 21.1 and 21.2, which are set on both sides of a narrow dryer fabric loop as seen from the side. The impingement surfaces are mainly delimited between the above-located roll 21.3 and the turning suction roll 20 21.4, although their hoods can extend to the curved section. Between these, on both surfaces, more precisely inside the fabric loop, there are support rolls 21.5 and blow boxes 21.6, such as is set forth for example in patent application 20002429. The support rolls can be grooved rolls, VAC rolls or suction rolls.

25 The center line of the vertical impingement dryer 21 deviates from the perpendicular by a maximum of 35°, such that it still saves machine-directional space. The preimpingement predryer may deviate as much as 60° from the horizontal.

The temperature of the blast gas in the impingement dryers (20, 21) is preferably in a range of 30 200°C-700°C, most preferably in a range of 250°C-400°C. The steam of the steambox (16.1) used for the preheating of impingement drying is preferably slightly (normally 7°C) superheated

and condenses on contacting the web, but not yet in the steambox. The web temperature can also be influenced by the impingement air moisture (air blow recirculation).

At the doctor of the first dryer cylinder 14.1 there is designed a web knock-down for web break  
5 situations. In this case the broke is conveyed to the pulper 30 along the upper flank 21.21 of the blowing unit 21.2 hood. In tail threading the web is run at full width to the pulper through the press and the impingement units. For tail threading, there is a tail squirt located in the vicinity of the cylinder 14.1 (not shown). In a center roll press, tail threading is carried out as a band over blowing units until to the said doctor.

10

In a normal situation the paper web travels with the dryer fabric 14.2 through the cylinder group to the subsequent group.

The impingement length of a horizontal impingement dryer is 50% at the maximum, most  
15 preferably 15-35% of the total web length of impingement. A greater pre-blowing length provides even drying in addition to preheating.

Figure 2 shows a preferable modification of the arrangement according to the invention as compared to Figure 1. Functionally similar parts are referred to using the same reference  
20 numbers as above.

Here it has been possible to leave out two transfer fabric loops, as the horizontal impingement dryer 20 has been placed on the press transfer belt 28. From the transfer belt 28 the paper web is transferred to the dryer fabric 19 of the vertical impingement dryer. In this figure it is  
25 separate, but it can as well be a part of the dryer fabric 14.2 of the first cylinder group as above.

The paper web transfer from the transfer belt 28 to the dryer fabric 19 takes place in a method known as such. The turning roll 28.1 takes the fabric loops together and the transfer suction roll 21.3 picks up the paper web onto its own dryer fabric 19. When the vertical impingement dryer  
30 is equipped with a fabric loop of its own, an additional transfer point is provided in connection with the first cylinder, at which transfer point it is possible to use a speed difference for

maintaining runnability. This has a particular importance when the dry content is lower, such as is set forth below.

General at a vertical impingement unit:

- 5 - An own fabric loop is arranged when the subsequent web dry content is 48-54%, or
- A fabric loop common with the short (maximum 3 dryer cylinders) dryer cylinder group when the dry content after the blowing units is 52-57%, or
- A fabric loop common with the long (4 or more cylinders) dryer cylinder group when the dry content after the blowing units is 56-65 %.

10

It should be noted that for quality reasons (e.g. with a weak furnish/web or in an embodiment according to Figure 2) it is possible, if necessary, to use an own fabric loop also with a higher dry content, arranging thus one additional transfer point.

- 15 The arrangement of Figure 3a is for the main parts similar as in Figure 1. The design of the impingement unit is however simplified such that inside the dryer fabric loop, between the auxiliary turning roll 21.4 and the vacuum roll 21.3, support rolls 21.5 of the same size as these rolls are used, which are preferably vacuum rolls, being actually the same as the turning suction rolls of the dryer cylinder. The suction boxes between these are of the same type as above.
- 20 Depicted with broken lines in this figure is also a possible steambox 16.1, the use of which provides completely new possibilities in impingement. In this figure it is located below the web, but it would also be possible to replace the first impingement box completely with the steambox. The application possibilities of the steambox are discussed below. In one modification the support rolls 21.5 are larger than rolls 21.3 and 21.4 such that the fabric touches the
- 25 rolls for a longer distance. This improves the suction effect, which enhances further the runnability.

The arrangement according to the invention can be used to improve the paper value for certain grades, in which the paper's bulk is significant. According to Figure 4, dry content and bulk

30 after press correlate inversely in different paper grades. Instead of using high nip pressures (1000 kN/m) at the press, the nip pressures are reduced in the first and second nip to a range of 400-800 kN/m. With the invention, drying of 1-2 percentages of dry matter is transferred from

the press section to impingement such that the paper's bulk is maintained. The increase in dry content for the impingement stages is preferably 3-12% in total before the dryer cylinders, more precisely 400% ( $\pm 100\%$ )/basis weight [g/m<sup>2</sup>], where a large range of fluctuation compensates the effect of the paper machine speed on the dry content.

5

With the invention, runnability is maintained, although the draw difference between the press and the first cylinder is set below 2.9%, most preferably below 2.5%, irrespective of the fact that the web is dried with impingement blows and is possibly transferred from a fabric to another even more than once.

10

Figure 3b shows another steambox application, in which all impingement blows are on the same side of the paper web, because preimpingement is carried out with steam. Reference numbering corresponds to the previous figures for applicable parts. Here installed on the fabric 14.2 of the first dryer group 14 there are also a steambox 16.1, vertical (straight) impingement 14.2 of the first dryer group 14 there are also a steambox 16.1, vertical (straight) impingement 15 unit 20.1 and the impingement unit 21 of the vacuum roll, before the first dryer cylinder 14.1. The paper web travels on the bottom surface of the fabric 14.2, onto which it has been transferred with the transfer suction roll 14.3. The steambox 16.1 efficiently increases the paper web temperature and consequently even a short impingement section dries the web surface on the cylinder side preventing it from attaching to the first dryer cylinder. By lowering the vacuum 20 roll 14.4, the impingement length can be increased in this embodiment, too, approaching thus the combination of preheating and vertical.

Differing from gas operated impingement, the steambox can be better located on the same side of the paper web as vertical impingement, because the heating effect provided by steam 25 condensing is particularly strong compared to gas convection. The steambox is profiling already as such, but it can be further divided into accurately profiling compartments in the cross-machine direction. Although condensing brings water to the paper web, this is not a great drawback when using impingement, because the paper web surface can in any case be made drier than without it, allowing full pressures in the first dryer cylinder.

30

The following advantages are associated with the use of steambox:

- Known as such as a process and currently used at the press. The steambox creates a temperature profile and drying continues more intensive from warmer places in the dryer section. The phenomenon is intensified with the proposed arrangement.
- More accurate, precise and efficient moisture profile control (compared to the traditional steambox use at the press), because the web does not get wet again after profiling.
- Increased drying capacity, since the web temperature is raised by 20-30°C before impingement.
- 10 - The moisture profile is controlled throughout the entire dryer section, as warmer places dry faster than the cold ones.
- Enables better optimization of press loads e.g. in solutions requiring bulk (load reduction at press).

15 Figures 5-10 show embodiments of the second group of the invention and equal reference symbols are used for corresponding parts unless otherwise indicated.

In the embodiment according to Figure 5, the web W is led from the press section 10, from the last press nip N thereof, which has been formed between rolls 12, 13, on the surface of the last fabric, most appropriately on the surface of a transfer belt or felt 11, to the first transfer fabric 20, to which the web W is transferred by means of the pick-up roll 21. On the transfer fabric 20 the web transfer is supported by blow boxes 25, which are most appropriately blow boxes of the type marketed by the applicant with the tradename PressRun. Followed by this there is a tail squirt 26 or a similar element for cutting a web threading tail, 25 which is followed by roll 30, with a movable position, which is most appropriately smooth and equipped with a doctor 31. For the tail threading, the roll 30 with a movable position is lifted to the top position, as shown with broken lines in the figure. From the smooth roll 30 the web is doctored with the doctor 31 to the pulper 41 during tail threading. The web travel to the pulper is ensured by a guide plate 42, and the chute 43 guides the web that has advanced any 30 further to the pulper 41 in a disturbance/when required. The chute 43 can also be separate from the impingement hood 51 and comprises water showers for guiding the web to the pulper 41. From the first transfer fabric 20 the web is led to a second transfer fabric 36, onto which the



web is transferred by means of the transfer suction roll 35. This can be followed by an impingement drying unit 40 located above the web on the transfer fabric 36. The guide and lead rolls of the first transfer fabric loop are indicated with reference number 22. The guide and lead rolls of the second transfer fabric loop are indicated with reference number 38. From the second transfer fabric 36 the web is led to vertical impingement drying, onto its dryer fabric 59, with which the web is transferred via the transfer suction roll 55. The guide and lead rolls of the dryer fabric loop 59 are indicated with reference number 54. First the web travels essentially vertically downwards, whereat it is dried with the impingement unit 51, after which the web travel direction is reversed at roll 53, after which the web W travel is essentially vertically upwards, during which travel it is dried by means of air blows provided by the impingement unit 52. After this the web is led on the dryer fabric 59 to cylinder drying, where the web W to be dried remains between the dryer fabric 59 and the heated cylinder surface 56 and the web W travel conforms to a normal single fabric run, whereat its travel is windingly turned with turning rolls or turning cylinders 57. The transfer suction rolls can also be moved to the tail threading position for the duration of tail threading of the web. For the transfer suction rolls, this position is also the standard operating position, such that tail threading and normal operation differ as regards the vacuum levels of the transfer suction rolls in that generally the vacuum used during tail threading is higher.

Exemplifying embodiments of the invention shown in the following Figures 6-8 correspond to the exemplifying embodiment of Figure 5 unless otherwise indicated.

In the embodiment shown in Figure 6 the web travel is essentially lineal and this has been so arranged that the second transfer fabric 36 extends to the area of the first transfer fabric loop 20 providing for the web a bilateral support, which allows arranging the web travel as essentially lineal. In this embodiment the web is transferred to the transfer fabric 36 with the transfer suction roll 37 and further to the dryer fabric 59 of the impingement drying group with the transfer suction roll 55. In this embodiment the first transfer fabric loop 20 is equipped with blow boxes 25, which are used to guide the web travel.

30

In the embodiment shown in Figure 7, the roll with a movable position is located inside the first transfer fabric loop 20 and it is indicated with reference number 22B, as it simultaneously

forms one of the guide and lead rolls of the transfer fabric loop during tail threading. Because this roll is movable, the transfer fabric loop is additionally provided with another roll 22a with an adjustable position for maintaining the tension of the transfer fabric loop 20. In the embodiment shown in Figure 7 the second transfer fabric loop 36 transports the web W only for a short distance mainly in the area of the transfer suction roll 37 and for a short section before the web W encounters the dryer fabric 59 of the impingement dryer group at the transfer suction roll 55. The other roll 34 of the transfer fabric loop 36 is movable for its position, as is illustrated in the figure with an arrow and the transfer position marked with broken lines. Thus the transfer fabric loop 36 can be moved away from contact with the transfer suction roll 55 of the impingement drying group such that the web W can be led to the pulper via the chute 43 in a disturbance/when required.

In the embodiment shown in Figure 8 the transfer fabric 20 is simultaneously the dryer fabric of the vertical group, which reduces the number of transfer points and thus the need of transfer suction rolls. The roll 33 is preferably a blow roll, and the suction box 58 can also make sure that the web W follows the fabric 20 in the downwardly fabric travel. In this way it is at the same time possible to increase the length of the impingement drying section. The roll 33 is preferably a blow roll, but by intensifying the vacuum device 58 it is possible to locate even a cylinder in this position, which however in a tail threading situation may be a slightly less advantageous alternative, because then it is necessary to controllably use the cylinder on the opposite side of the blow roll only over the width of the proceeding band. In case the roll 33 is a blow roll, it can be for example a warm blow roll, approximately 140°C inside the roll, or the roll can be a grooved roll, the groove size of which is 1 x 1 mm and then its effect is intensified with the vacuum device 58.

25

In the embodiments of Figures 6- 8 impingement drying is carried out with steamboxes according to Figure 3b.

Referring to the embodiments of Figures 5-8, the web dry content is raised in the dryer section of a paper machine to a sufficient value, being typically 50-65% of dry matter, even 70% of dry matter before dryer cylinders are used for drying. According to the invention the paper web is thus dried after the press section with impingement drying in a vertical impingement drying

group before cylinder drying. According to the invention, in the method the paper web is led from the press section to the vertical impingement drying group from the last fabric of the press section, i.e. a transbelt or a felt, by means of at least one transfer fabric.

5 In connection with the invention (especially Figures 5-8), arranged in connection with at least one transfer fabric used for leading the web from the press section to the first vertical impingement drying group of the dryer section, there is preferably a roll with a movable position or similar, for example, which for the duration of tail threading is moved to the tail threading position, most appropriately to the top position, and after tail threading to a position, in which  
10 it does not affect the web travel. The section of the web to be led from the movable roll to the pulper can be selected for example by moistening the roll over this desired width, thus the tail position in the roll continuing further in tail threading would be dry, and correspondingly it is possible to moisten the roll over the entire width when running down the entire wide web. Arranged in connection with the transfer fabric there are preferably blow boxes, providing a  
15 vacuum effect, by means of which the web is kept in the conveyance of the transfer fabric. According to one preferable additional feature of the invention, the first transfer fabric is followed by a second transfer fabric, which is located below the web and by means of which the web is led to the dryer fabric of the vertical impingement drying group.

20 According to one preferable embodiment of the invention, the web is led from the last press nip of the press section on the surface of the last fabric, most appropriately a transbelt or a felt, from which the web is transferred to the first transfer fabric. The web transfer is then followed by a tail squirt or other similar device for cutting a web threading tail. This is followed by a roll with a movable position, most appropriately a smooth roll, associated with a doctor. The web  
25 is run at full width from the pick-up roll of the first transfer fabric loop, i.e. from the roll that picks it up from the previous fabric, to the roll with a movable position, which has been moved to the tail threading position, to the top position, while the pick-up roll goes down and picks up the web from the last fabric of the press section. Because the transfer fabric covers a part of the roll with a movable position, the web follows the roll and arrives at the roll doctor, from where  
30 it slides down to the pulper. After this the concept includes a second transfer fabric, which is used to take the web to the dryer fabric of the vertical impingement drying group. The drying effect of the vertical impingement drying unit is such that the web dry content can be raised to

a level of 50-65% of dry matter, most appropriately 55-63% of dry matter, before leading the web to cylinder drying. The roll with a movable position is in the top position while the web threading tail is transported over the vertical impingement unit, and once the web is widened, the roll with a movable position is lowered to a position unaffected by the web travel, to the  
5 bottom position such that it does not create a problem point as regards the opening gap, as in this case an opening gap, in which vacuum complicating runnability, harmful for the web travel would otherwise be created, is not formed. Located inside the loop of the first transfer fabric there are blow boxes, most appropriately boxes of the type marketed by the applicant with the tradename PressRun, for ensuring the web travel.

10

In the exemplifying embodiment of the invention shown in Figure 9, the web W is led from the press section P, from the last nip Nx thereof, with the bottom fabric 11 of the press to position Xl, in which the web W travel takes a steep curve downwards at the roll 12 to vertical impingement drying 20, in which the web W is dried, in the downwardly section thereof, by means of  
15 drying air blows provided by the impingement drying unit 21. The lead and guide rolls of the fabric 11 are indicated with reference number 23. Located in the section between the last press nip Nx and position Xl there is the impingement drying unit 15 for preimpingement, which preferably provides more drying blow length for impingement drying. According to this embodiment, too, when using the last press section fabric 11, savings are made in fabric  
20 arrangements and the related roll arrangements. After the downwardly impingement drying 20, the web W is led onto the dryer fabric 32 of the first dryer group R1, on which the web W, after the horizontal section, in which the web W is supported by vacuum boxes 33, is first turned by means of roll 35 to vertical upwardly impingement drying 30, whereat the web W is dried with drying air blows provided with the impingement drying unit 36, after which the web W is taken  
25 to cylinder drying applying the single fabric run arrangement, in which the web W windingly travels on the dryer cylinders 43 and the suction or turning cylinder 42. The runnability of the web W is intensified by the vacuum components 41. In a knock-down situation, such as tail threading and web break, it is possible to lead the web W from the cylinder drying section R1 to the pulper 50 at one of its first dryer cylinders. The pulper chute is indicated with reference  
30 number 59.



In the embodiment of the invention shown in Figure 10, the web W is led from the last press nip Nx of the press section on the surface of the last bottom fabric 11 of the press section, where the press nip Nx is first followed by preimpingement in the horizontal impingement drying unit 15, after which in position Xl the web W takes a curve downwards at roll 12 on fabric 11, from which it is picked up onto the dryer fabric 32 of the first dryer group Rl with the transfer suction roll 38 and the web W is led to vertical impingement drying 20, in which the web W is dried in an essentially downwardly section by means of drying air blows provided by the impingement drying unit 21. Keeping the web W attached to the fabric 32 surface is facilitated by the vacuum boxes 34. The web W travel is turned to an essentially upwardly direction at roll 35, in which upwardly travel the web W is dried with vertical impingement drying 30 by means of drying air blows provided by the impingement drying unit 36, after which the web W is led to cylinder drying applying the single fabric run arrangement. The pulper is indicated with reference number 50 and the pulper chute with reference number 59. In a knock-down situation the web W is led to the pulper 50 from one of its first cylinders of its first dryer group. This embodiment of the invention enables locating another pulper 55 after the press section P before vertical impingement drying 20.

In one simulation the paper grade used was fine paper 78 g/m<sup>2</sup>, preimpingement length 6 m, and the paper temperature coming from the press section has been assumed to be 45°C. In this case preblowing warms up the web to 74°C. This is followed by 2.7 meters of blowless run while moving to the subsequent fabric and to a new impingement unit, whereat the web temperature falls to 65°C, that is, approximately 9°C is lost from the temperature increase of 29°C. Over six meters the decrease is 6.5°C or more. Over a blowless interval of 8 meters the web temperature decreased further to 55.5°C, i.e. by 19.5°C. Lighter paper cools down faster and heavier paper correspondingly cools down slower. This blowless length varies due to, for example, the web transfer geometry, moving from a fabric to another, the space required by the lead rolls, or the required transfer fabric.



## Claims

1. An arrangement in a paper machine or similar, which includes a press section (11) equipped with one or more press nips (13.1, 13.2) and a dryer section comprising a web-supporting web transfer, a vertical impingement dryer (21) and one or more subsequent cylinder dryer groups (14), each of which groups have several dryer cylinders (14.1), characterized in that the arrangement comprises a preimpingement dryer (20) immediately before the vertical impingement dryer (21) for preheating the paper web before vertical impingement.
2. An arrangement according to claim 1, characterized in that the preimpingement dryer (20) is gas-operated and set to dry a different side of the paper web than the vertical impingement dryer (21).
3. An arrangement according to claim 2, characterized in that the preimpingement dryer (20) comprises a maximum of 50%, most preferably 15-35% of the total impingement length.
4. An arrangement according to claim 1, characterized in that the preimpingement dryer (20) is straight and the inclination deviates 60° at the maximum from the horizontal.
5. An arrangement according to any of the preceding claims 1-4, in which associated with the last nip (13.2) of the press section (11) there is a loop formed by a transfer belt (28), characterized in that the preimpingement dryer (20) is set on the said transfer belt (28).
6. An arrangement according to any of the claims 1-5, characterized in that the vertical impingement dryer (21) comprises two impingement dryers (21.1, 21.2) set on the opposite side of a down-extending web transfer, short in the machine-direction, arranged to dry the same paper web side.
7. An arrangement according to claim 6, characterized in that the vertical impingement dryer (21) comprises several rolls (21.4, 21.5), which support and lead the said down-extending web transfer of the dryer fabric 14.2 on the inner side of the fabric loop.

8. An arrangement according to any of claims 1-6, characterized in that the center line of the vertical impingement dryer (21) deviates a maximum of 35° from the perpendicular.
9. An arrangement according to any of claims 1-8, characterized in that the blast gas  
5 temperature in at least one impingement dryer (20, 21) is in a range of 250°C-700°C.
10. An arrangement according to any of claims 1-9, characterized in that the vertical impingement dryer (21) is set to dry unilaterally and the same side as the first subsequent dryer cylinder (14.1).
- 10 11. An arrangement according to any of claims 1-10, characterized in that the draw difference from the press to the first cylinder is arranged to be set below 2.9%, most preferably below 2.5%.
- 15 12. An arrangement according to any of claims 1-10, characterized in that for the vertical impingement unit there is
- arranged an own fabric loop when the subsequent dry content - moisture is 48-54%, or
  - a fabric loop common with the short dryer cylinder group when the dry content - moisture after the blowing units is 52-57%, or
  - 20 - a fabric loop common with the long dryer cylinder group when the dry content - moisture after the blowing units is 56-65 %.
13. An arrangement according to claim 1, characterized in that preimpingement drying comprises a steambox (16.1).

## AMENDED CLAIMS

[Received by the International Bureau on 21 June 2005 (21.06.2005)]

## Claims

1. An arrangement in a paper machine or similar, which includes a press section (11) equipped with one or more press nips (13.1, 13.2) and a dryer section comprising a web-supporting web transfer, a vertical impingement dryer (21) and one or more cylinder dryer groups, where the first dryer cylinder (14.1) of the first cylinder dryer group (14) is subsequent to the vertical impingement dryer (21), characterized in that the arrangement comprises a preimpingement dryer (20) immediately before the vertical impingement dryer (21) for preheating the paper web before vertical impingement.
2. An arrangement according to claim 1, characterized in that the preimpingement dryer (20) is gas-operated and set to dry a different side of the paper web than the vertical impingement dryer (21).
3. An arrangement according to claim 2, characterized in that the preimpingement dryer (20) comprises a maximum of 50%, most preferably 15-35% of the total impingement length.
4. An arrangement according to claim 1, characterized in that the preimpingement dryer (20) is straight and the inclination deviates 60° at the maximum from the horizontal.
5. An arrangement according to any of the preceding claims 1-4, in which associated with the last nip (13.2) of the press section (11) there is a loop formed by a transfer belt (28), characterized in that the preimpingement dryer (20) is set on the said transfer belt (28).
6. An arrangement according to any of the claims 1-5, characterized in that the vertical impingement dryer (21) comprises two impingement dryers (21.1, 21.2) set on the opposite side of a down-extending web transfer, short in the machine-direction, arranged to dry the same paper web side.
7. An arrangement according to claim 6, characterized in that the vertical impingement dryer (21) comprises several rolls (21.4, 21.5), which support and lead the said down-extending web transfer of the dryer fabric 14.2 on the inner side of the fabric loop.

8. An arrangement according to any of claims 1-6, characterized in that the center line of the vertical impingement dryer (21) deviates a maximum of 35° from the perpendicular.
9. An arrangement according to any of claims 1-8, characterized in that the blast gas  
5 temperature in at least one impingement dryer (20, 21) is in a range of 250°C-700°C.
10. An arrangement according to any of claims 1-9, characterized in that the vertical  
impingement dryer (21) is set to dry unilaterally and the same side as the first subsequent dryer  
cylinder (14.1).
- 10
11. An arrangement according to any of claims 1-10, characterized in that the draw differ-  
ence from the press to the first cylinder is arranged to be set below 2.9%, most preferably below  
2.5%.
- 15 12. An arrangement according to any of claims 1-10, characterized in that for the vertical  
impingement unit there is
- arranged an own fabric loop when the subsequent dry content - moisture is 48-54%, or
  - a fabric loop common with the short dryer cylinder group when the dry content - mois-  
ture after the blowing units is 52-57%, or
  - 20 - a fabric loop common with the long dryer cylinder group when the dry content - moisture  
after the blowing units is 56-65 %.
13. An arrangement according to claim 1, characterized in that preimpingement drying  
comprises a steambox (16.1).

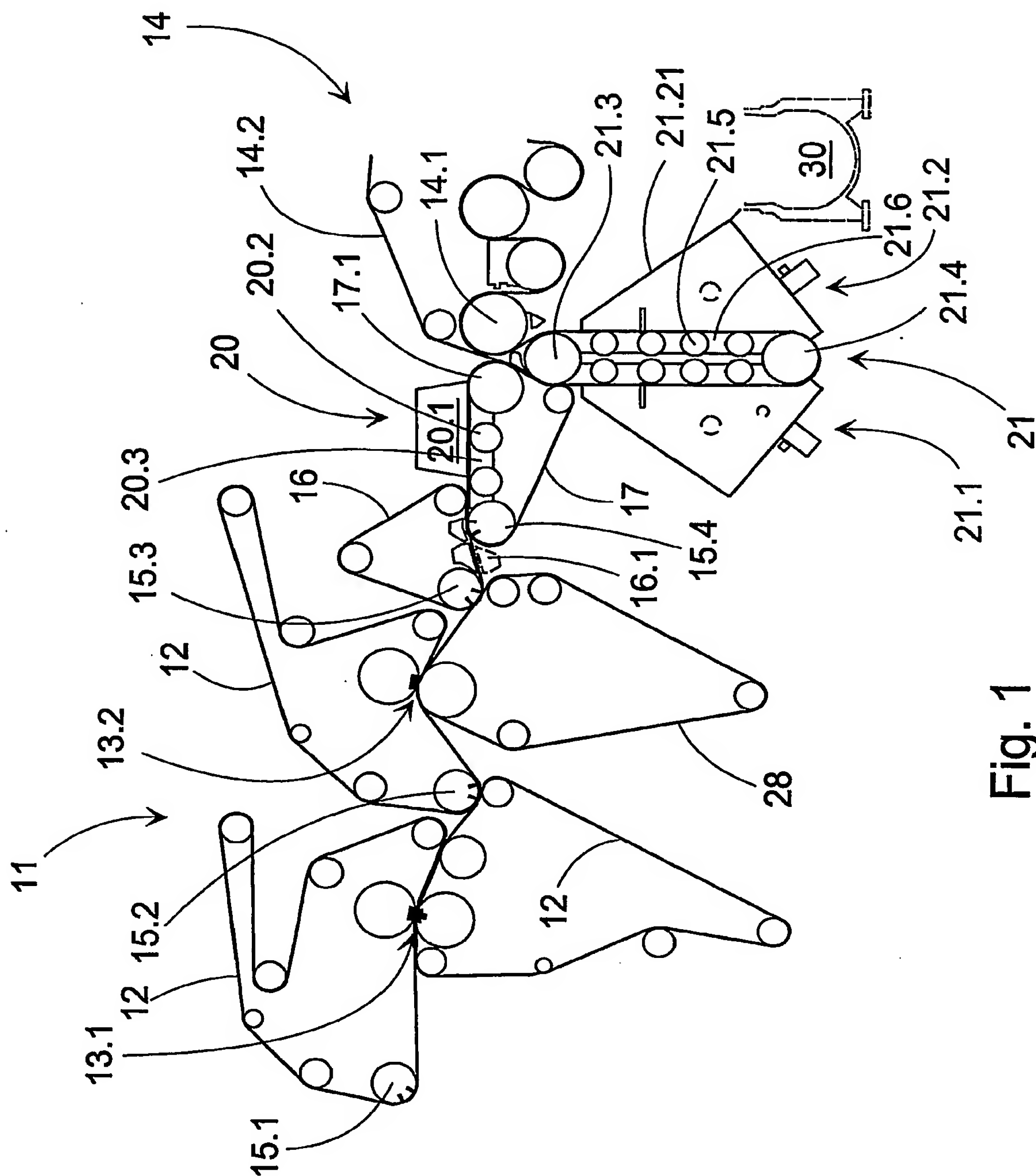


Fig. 1



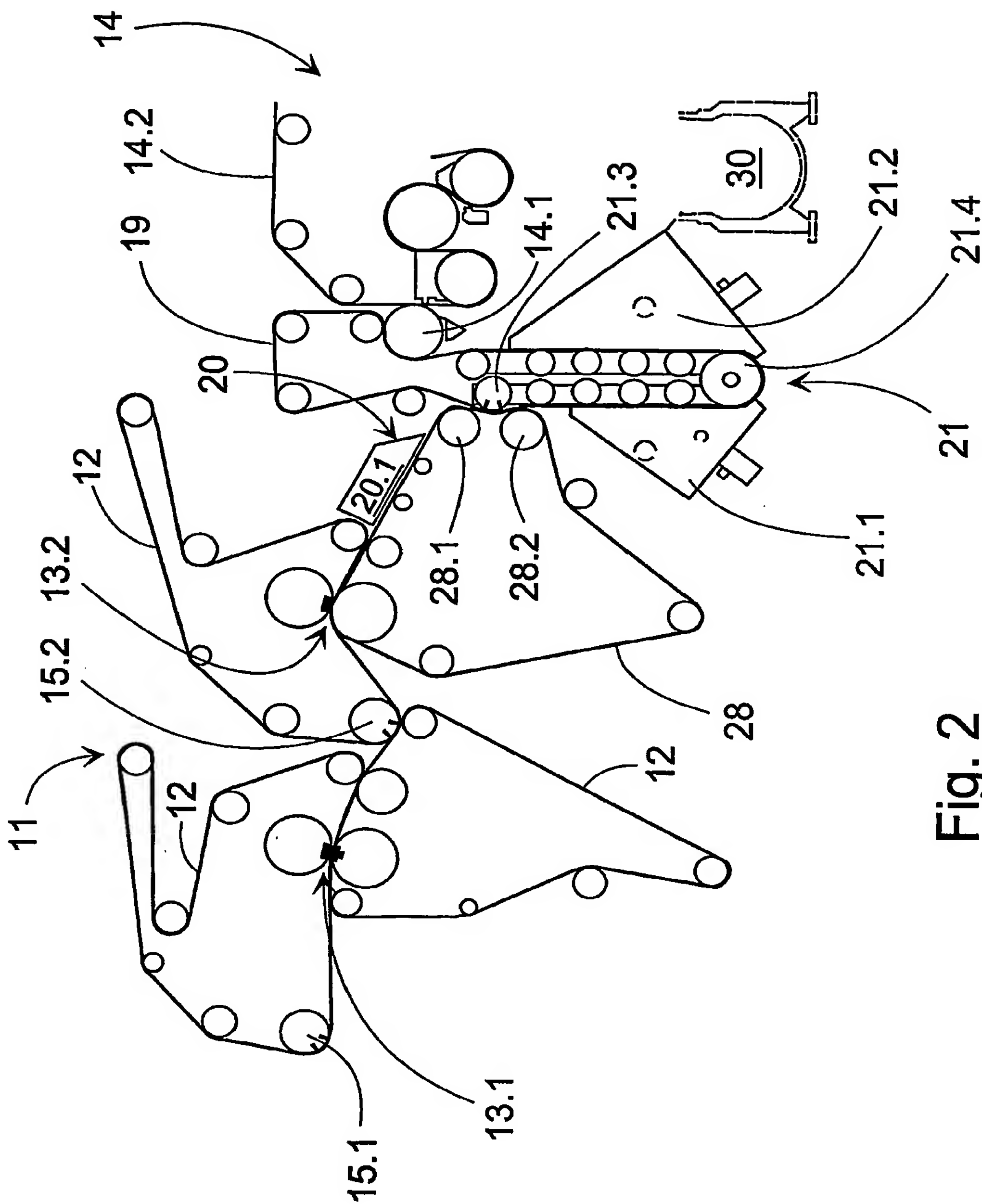


Fig. 2

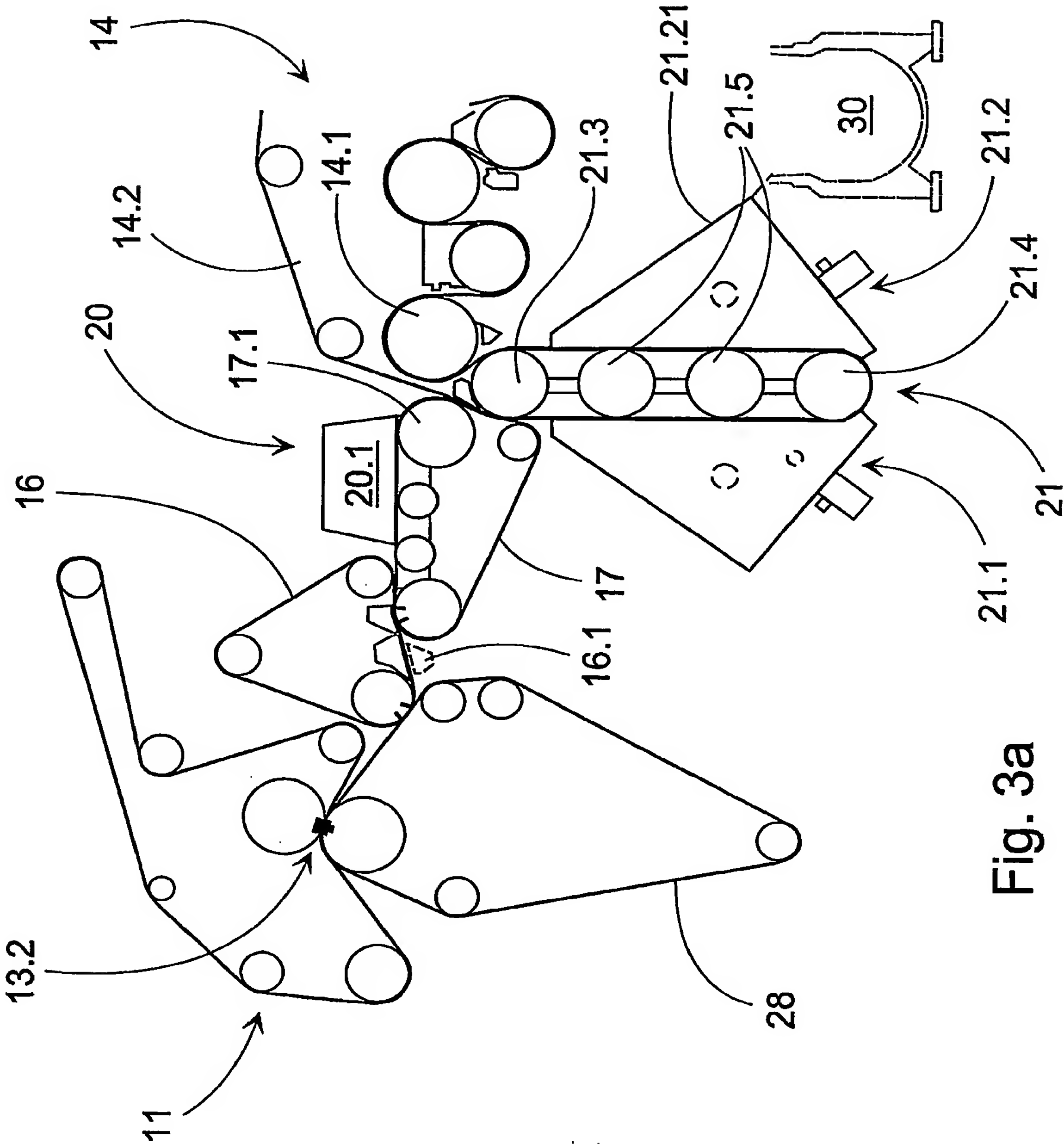


Fig. 3a

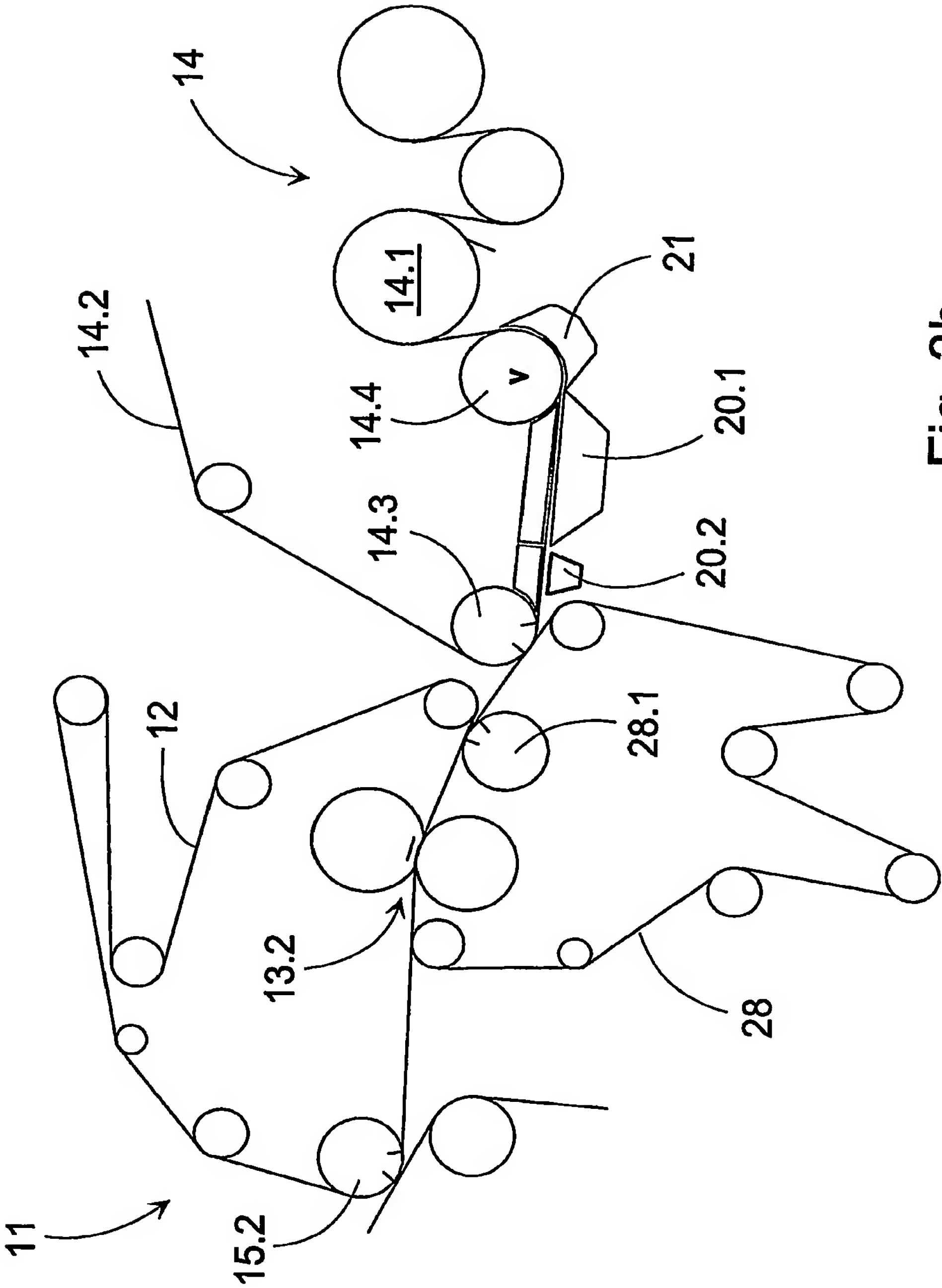


Fig. 3b

5/11

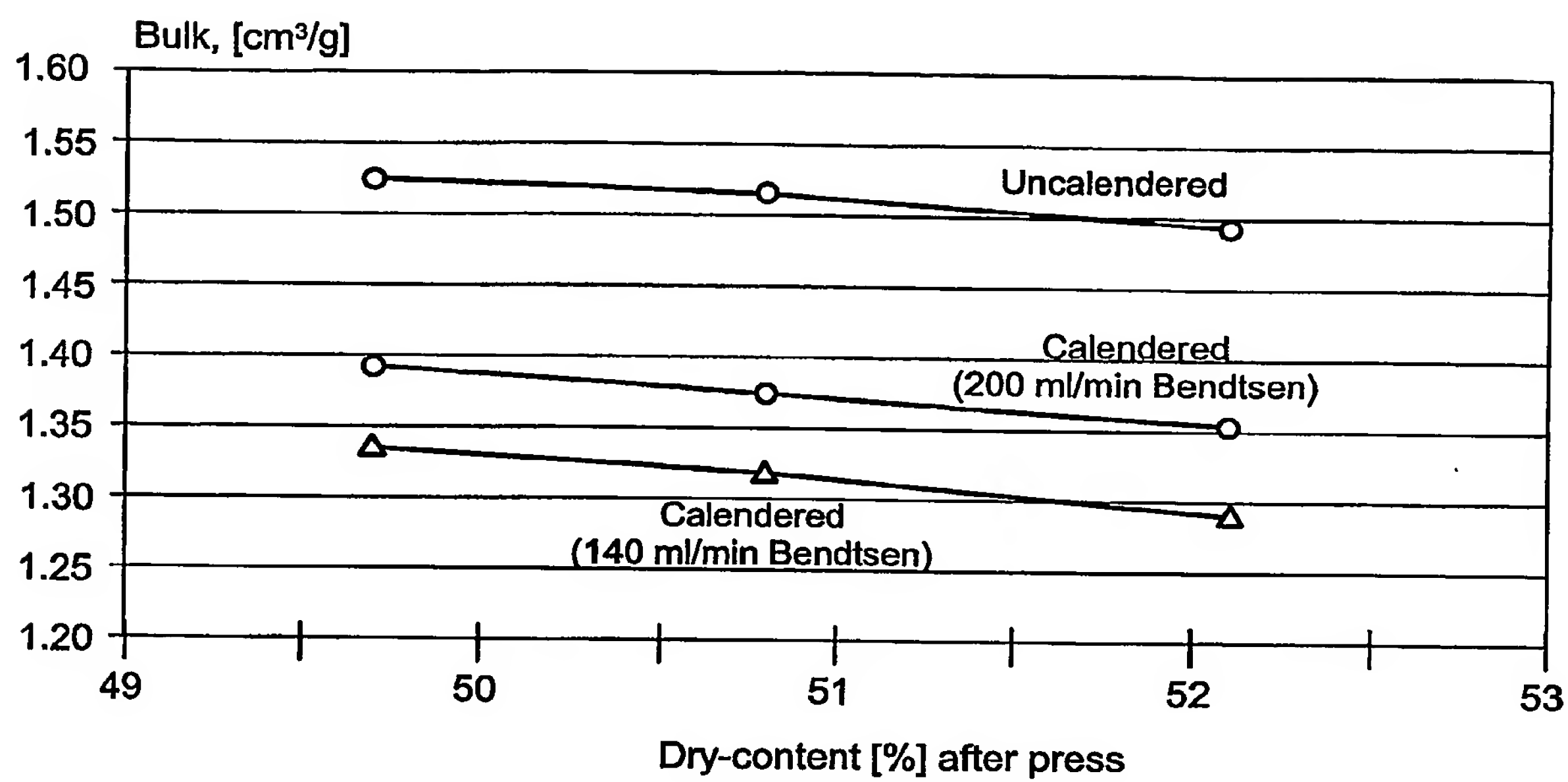


Fig. 4

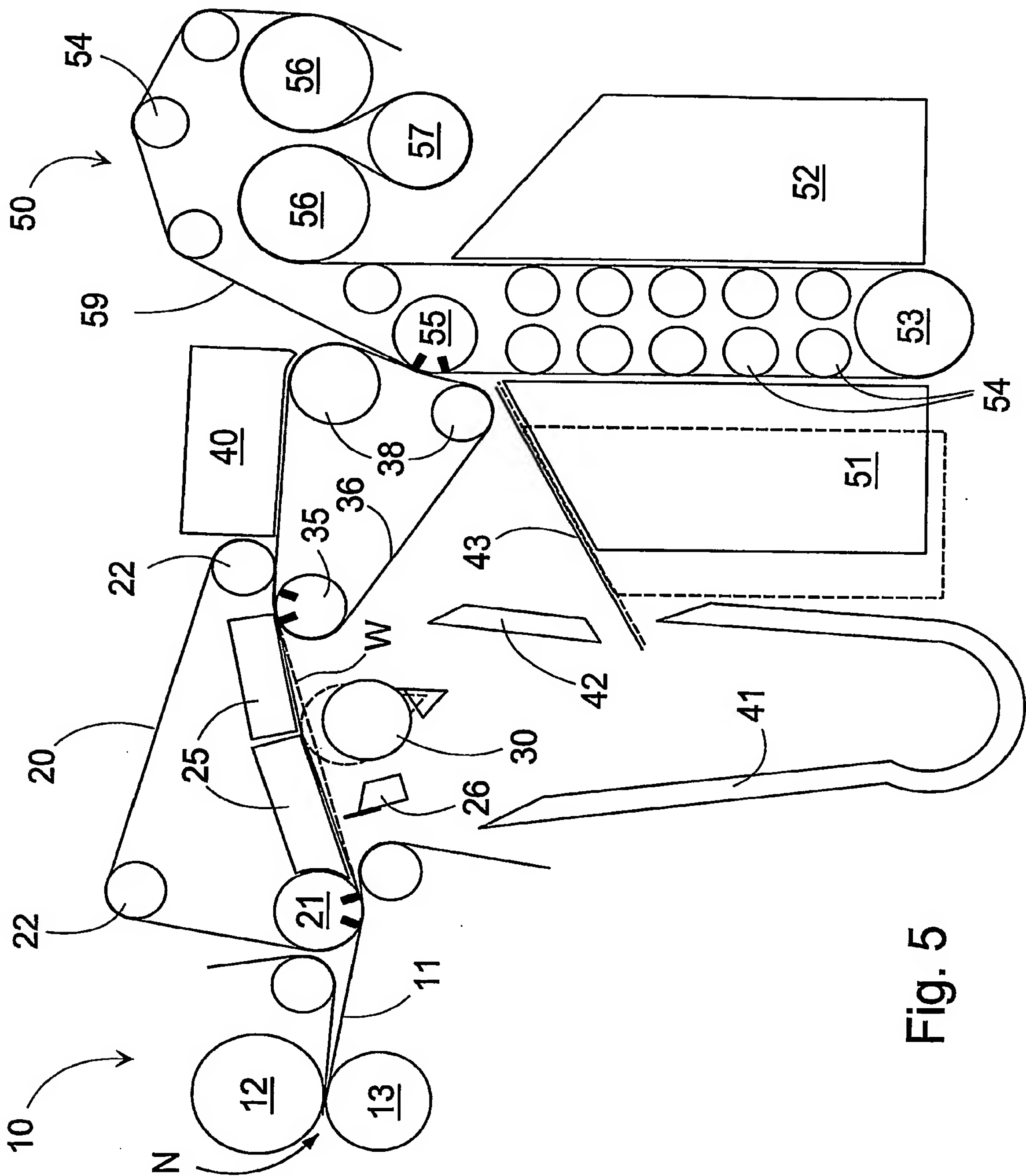


Fig. 5



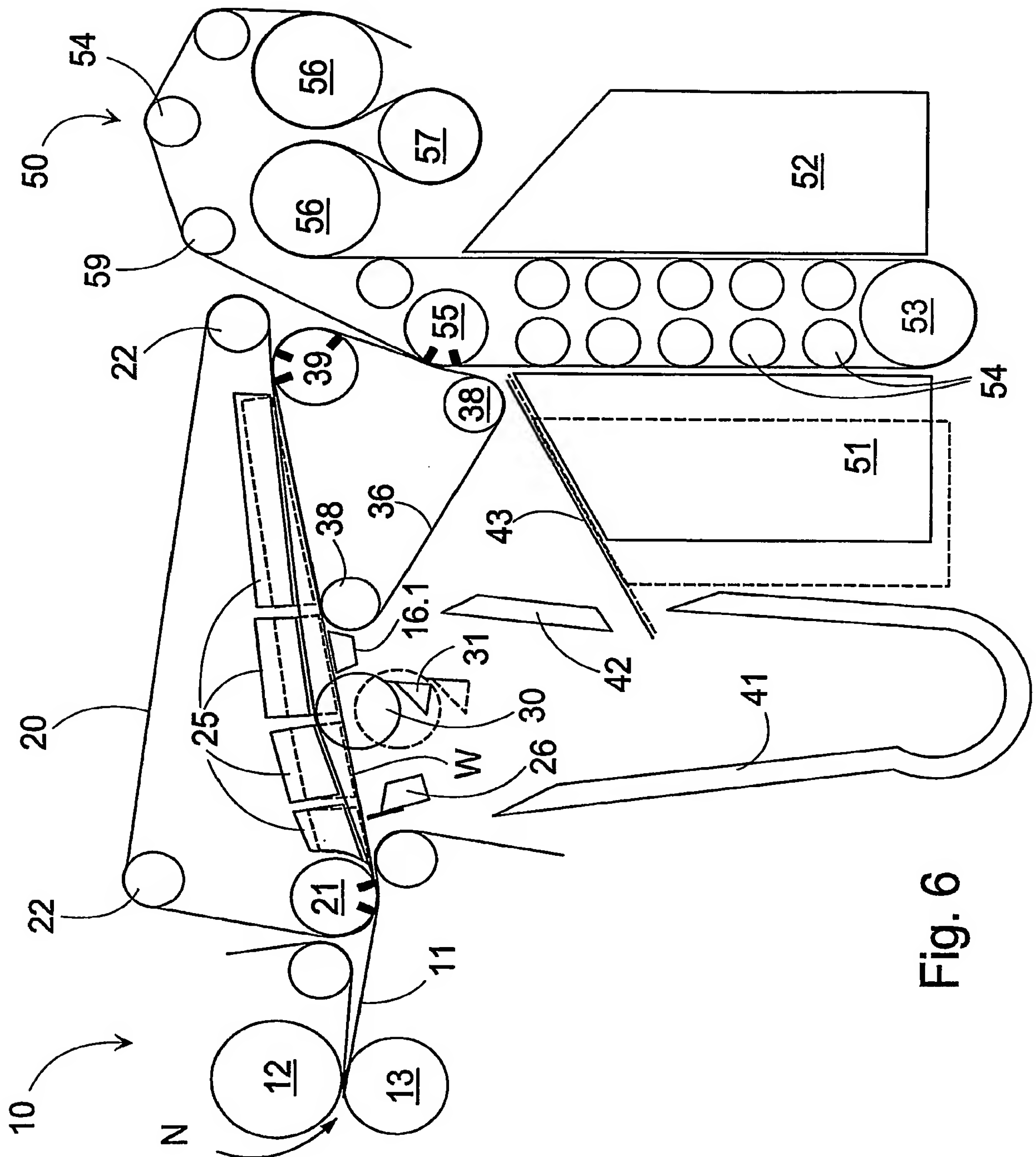


Fig. 6

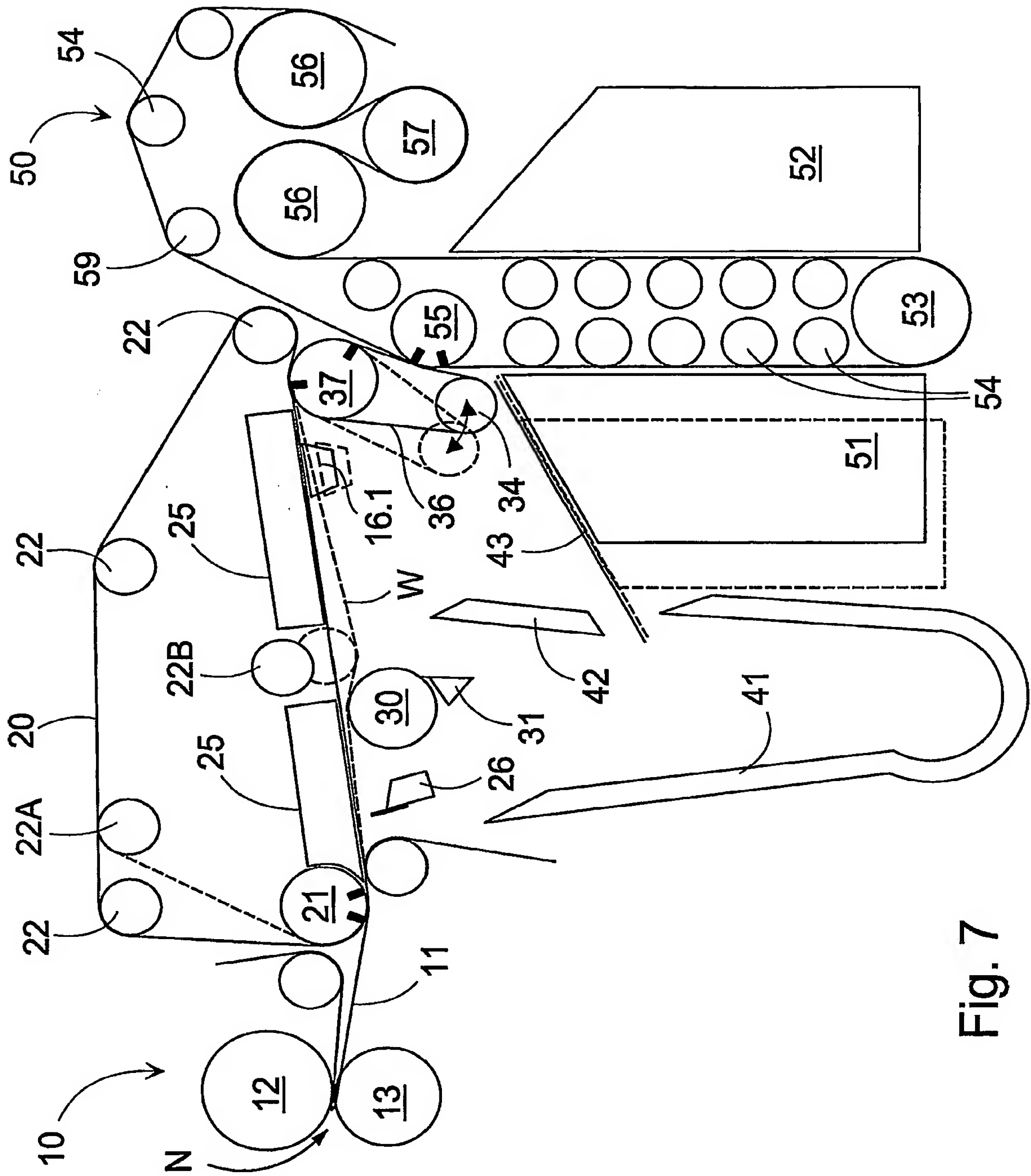


Fig. 7

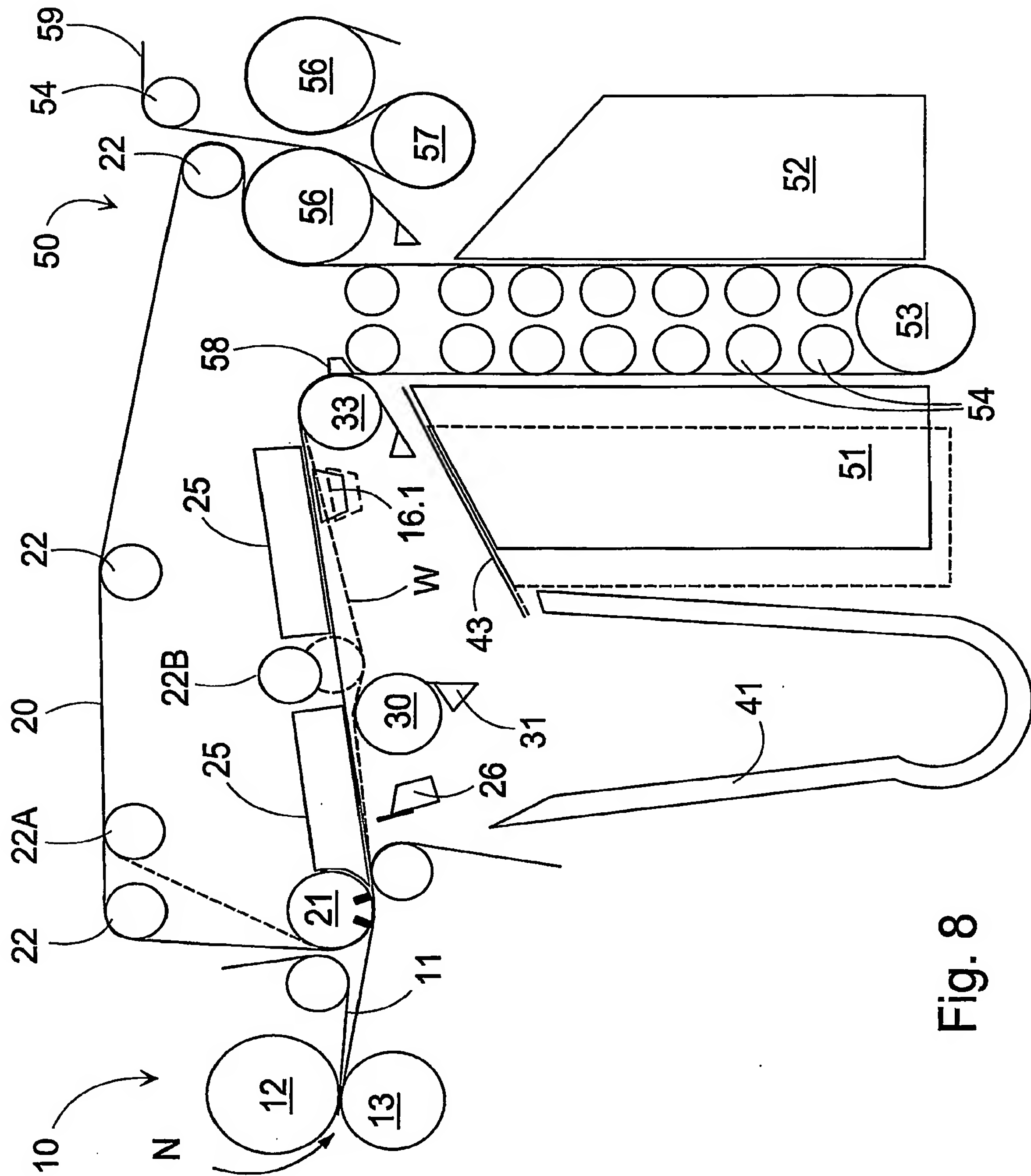


Fig. 8

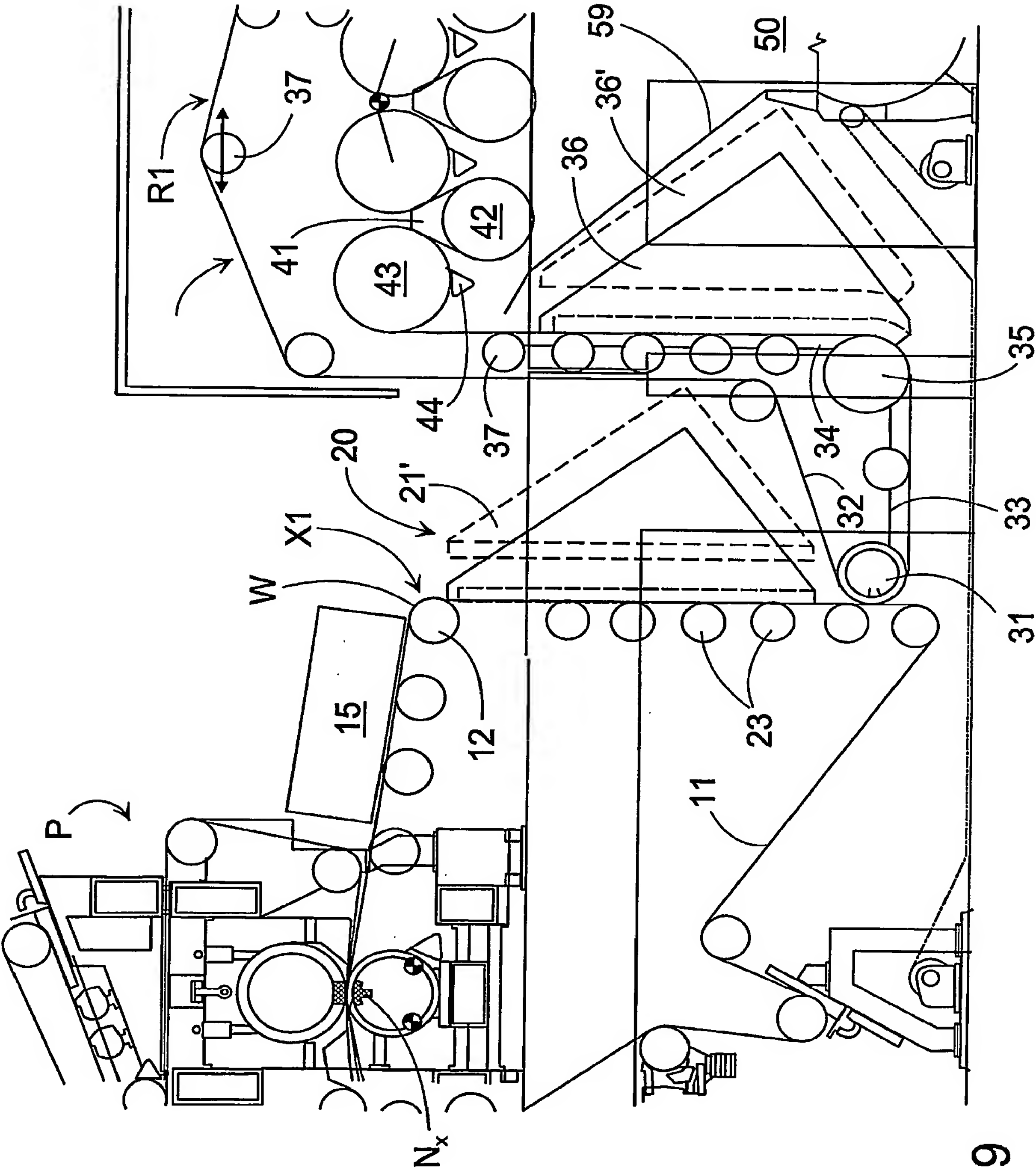


Fig. 9

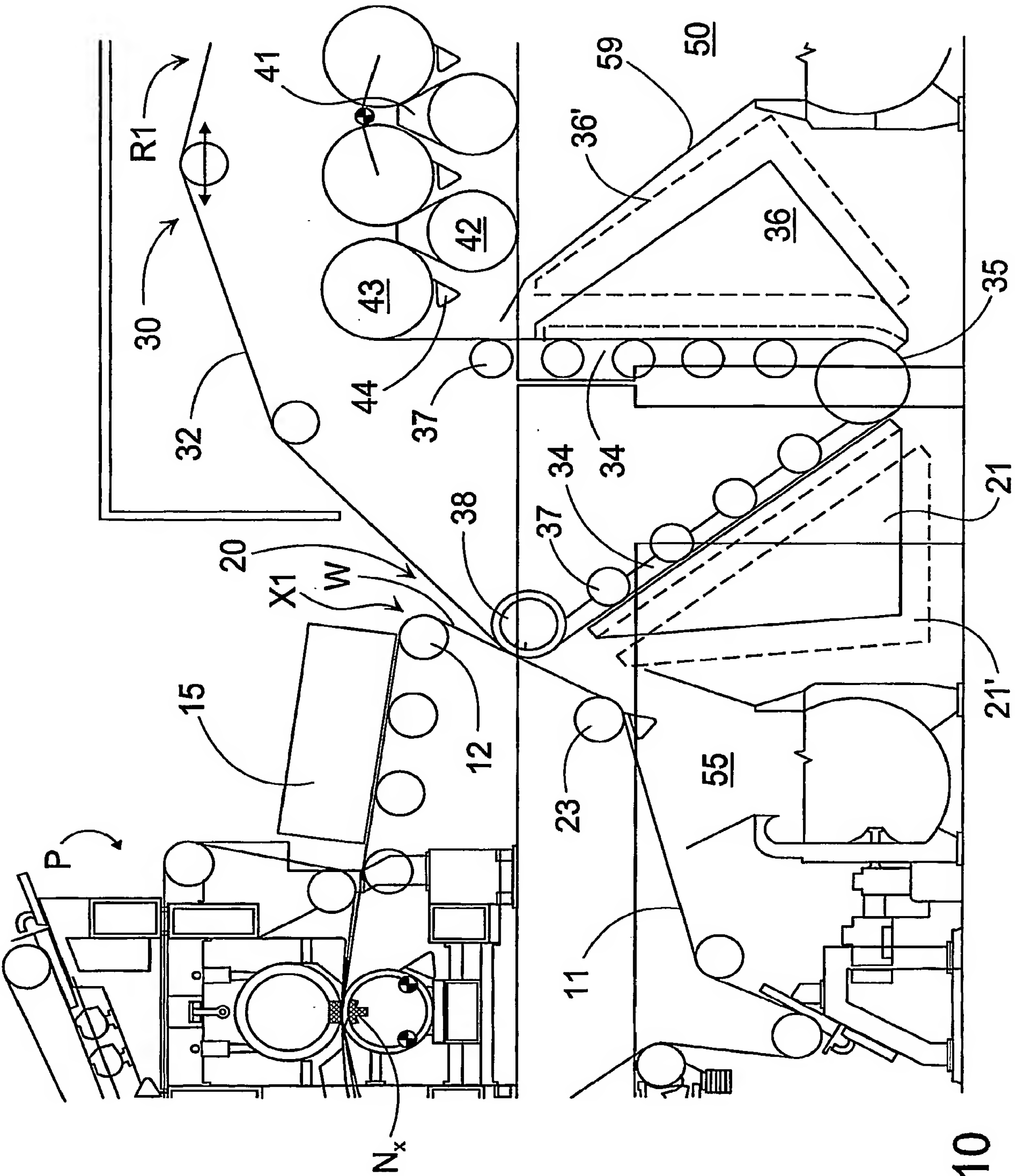


Fig. 10



## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/FI 2005/050006

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: D21F 5/18, D21F 5/04

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: D21F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6442865 B1 (ROBERT WOLF ET AL), 3 Sept 2002 (03.09.2002), column 3, line 46 - line 50; column 8, line 11 - line 16, claims 1,8-10,22, abstract --	1-13
Y	WO 9856983 A1 (VALMET CORPORATION), 17 December 1998 (17.12.1998), page 17, line 29 - page 18, line 8, figure 12, claims 1,2, abstract --	1-13
Y	US 4361466 A (GEORGE H. WONG ET AL), 30 November 1982 (30.11.1982), claim 1, abstract --	1-13

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

\* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search

7 April 2005

Date of mailing of the international search report

26 -04- 2005

Name and mailing address of the ISA/  
Swedish Patent Office  
Box 5055, S-102 42 STOCKHOLM  
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Telephone No. +46 8 782 25 00

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 2005/050006

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5865955 A (HEIKKI ILVESPÄÄ ET AL), 2 February 1999 (02.02.1999), claims 1,15,34, abstract --	1-13
Y	WO 0236880 A1 (METSO PAPER, INC.), 10 May 2002 (10.05.2002), claim 1, abstract -- -----	1-13

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

01/03/2005

International application No.  
PCT/FI 2005/050006

US	6442865	B1	03/09/2002	DE	19935138	A	04/05/2000
				DE	50008807	D	00/00/0000
				EP	1072722	A,B	31/01/2001
				SE	1072722	T3	
<hr/>							
WO	9856983	A1	17/12/1998	AU	7533098	A	30/12/1998
				DE	19882441	T	11/05/2000
				FI	106806	B	00/00/0000
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				CA	1126013	A	22/06/1982
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				CA	2233487	A	10/04/1997
				CN	1088482	B,C	31/07/2002
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				DE	69620020	D,T	22/08/2002
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				SE	0868569	T3	
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				JP	11512791	T	02/11/1999
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				EP	1337707	A	27/08/2003
				FI	20002429	A	07/05/2002
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				US	20040049940	A	18/03/2004
<hr/>							

# PCT

WIPO

PCT

**(PCT Article 36 and Rule 70)**

4. This report contains indications relating to the following items:

<input checked="" type="checkbox"/>	Box No. I	Basis of the report
<input type="checkbox"/>	Box No. II	Priority
<input type="checkbox"/>	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
<input type="checkbox"/>	Box No. IV	Lack of unity of invention
<input checked="" type="checkbox"/>	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
<input type="checkbox"/>	Box No. VI	Certain documents cited
<input type="checkbox"/>	Box No. VII	Certain defects in the international application
<input type="checkbox"/>	Box No. VIII	Certain observations on the international application

Date of submission of the demand	Date of completion of this report
19-10-2005	18-04-2006
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. +46 8 667 72 88	Authorized officer  Mats Raidla/ELY Telephone No. +46 8 782 25 00

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/FI2005/050006

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.  
Continuation of: Cover sheet

**International patent classification (IPC)**

**D21F 5/04 (2006.01)**  
**D21F 5/18 (2006.01)**



INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/FI2005/050006

Box No. I Basis of the report

1. With regard to the language, this report is based on:

☒ the international application in the language in which it was filed

☐ a translation of the international application into \_\_\_\_\_,  
which is the language of a translation furnished for the purposes of:

☐ international search (Rules 12.3(a) and 23.1(b))

☐ publication of the international application (Rule 12.4(a))

☐ international preliminary examination (Rules 55.2(a) and/or 55.3(a))

2. With regard to the elements of the international application, this report is based on (*replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report*):

☐ the international application as originally filed/furnished

☒ the description:

pages 1-15 as originally filed/furnished

pages\* \_\_\_\_\_ received by this Authority on \_\_\_\_\_

pages\* \_\_\_\_\_ received by this Authority on \_\_\_\_\_

☒ the claims:

pages \_\_\_\_\_ as originally filed/furnished

pages\* \_\_\_\_\_ as amended (together with any statement) under Article 19

pages\* 17-18 received by this Authority on 19-10-2005

pages\* \_\_\_\_\_ received by this Authority on \_\_\_\_\_

☒ the drawings:

pages 1-11 as originally filed/furnished

pages\* \_\_\_\_\_ received by this Authority on \_\_\_\_\_

pages\* \_\_\_\_\_ received by this Authority on \_\_\_\_\_

☐ a sequence listing and/or any related table(s) – see Supplemental Box Relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages \_\_\_\_\_

☐ the claims, Nos. \_\_\_\_\_

☐ the drawings, sheets/figs \_\_\_\_\_

☐ the sequence listing (*specify*): \_\_\_\_\_

☐ any table(s) related to the sequence listing (*specify*): \_\_\_\_\_

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

☐ the description, pages \_\_\_\_\_

☐ the claims, Nos. \_\_\_\_\_

☐ the drawings, sheets/figs \_\_\_\_\_

☐ the sequence listing (*specify*): \_\_\_\_\_

☐ any table(s) related to the sequence listing (*specify*): \_\_\_\_\_

\* If item 4 applies, some or all of those sheets may be marked "superseded."

## INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/FI2005/050006

**Box No. V** Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

## 1. Statement

Novelty (N)	Claims	<u>1-13</u>	YES
	Claims		NO
Inventive step (IS)	Claims	<u>1-13</u>	YES
	Claims		NO
Industrial applicability (IA)	Claims	<u>1-13</u>	YES
	Claims		NO

## 2. Citations and explanations (Rule 70.7)

Documents cited in the International Search Report:

D1: US 6442865 B1

D2: WO 9856983 A1

D3: US 4361466 A

D4: US 5865955 A

D5: WO 0236880 A1

The cited documents represent the general state of the art.  
The invention defined in amended claims 1-13 is not disclosed  
by any of these documents.

The cited prior art does not give any indication that would  
lead a person skilled in the art to the claimed arrangement in  
a paper machine or similar. Therefore, the claimed invention  
is not obvious to a person skilled in the art.

Accordingly, the invention defined in amended claims 1-13 is  
novel and is considered to involve an inventive step. The  
invention is industrially applicable.

## Claims

1. An arrangement in a paper machine or similar, which includes a press section (11) equipped with one or more press nips (13.1, 13.2) and a dryer section comprising a web-supporting web transfer, a vertical impingement dryer (21) and one or more cylinder dryer groups, where the first dryer cylinder (14.1) of the first cylinder dryer group (14) is subsequent to the vertical impingement dryer (21), characterized in that the arrangement comprises a preimpingement dryer (20) with direct blowing against the paper web immediately before the vertical impingement dryer (21) for preheating the paper web before vertical impingement.
2. An arrangement according to claim 1, characterized in that the preimpingement dryer (20) is gas-operated and set to dry a different side of the paper web than the vertical impingement dryer (21).
3. An arrangement according to claim 2, characterized in that the preimpingement dryer (20) comprises a maximum of 50%, most preferably 15-35% of the total impingement length.
4. An arrangement according to claim 1, characterized in that the preimpingement dryer (20) is straight and the inclination deviates 60° at the maximum from the horizontal.
5. An arrangement according to any of the preceding claims 1-4, in which associated with the last nip (13.2) of the press section (11) there is a loop formed by a transfer belt (28), characterized in that the preimpingement dryer (20) is set on the said transfer belt (28).
6. An arrangement according to any of the claims 1-5, characterized in that the vertical impingement dryer (21) comprises two impingement dryers (21.1, 21.2) set on the opposite side of a down-extending web transfer, short in the machine-direction, arranged to dry the same paper web side.
7. An arrangement according to claim 6, characterized in that the vertical impingement dryer (21) comprises several rolls (21.4, 21.5), which support and lead the said down-extending web transfer of the dryer fabric 14.2 on the inner side of the fabric loop.

AMENDED SHEET

8. An arrangement according to any of claims 1-6, characterized in that the center line of the vertical impingement dryer (21) deviates a maximum of 35° from the perpendicular.
9. An arrangement according to any of claims 1-8, characterized in that the blast gas temperature in at least one impingement dryer (20, 21) is in a range of 250°C-700°C.
10. An arrangement according to any of claims 1-9, characterized in that the vertical impingement dryer (21) is set to dry unilaterally and the same side as the first subsequent dryer cylinder (14.1).
11. An arrangement according to any of claims 1-10, characterized in that the draw difference from the press to the first cylinder is arranged to be set below 2.9%, most preferably below 2.5%.
12. An arrangement according to any of claims 1-10, characterized in that for the vertical impingement unit there is
- arranged an own fabric loop when the subsequent dry content - moisture is 48-54%, or
  - a fabric loop common with the short dryer cylinder group when the dry content - moisture after the blowing units is 52-57%, or
  - a fabric loop common with the long dryer cylinder group when the dry content - moisture after the blowing units is 56-65 %.
13. An arrangement according to claim 1, characterized in that preimpingement drying comprises a steambox (16.1).

AMENDED SHEET